Health of Towns Association.

ANALYSIS OF EVIDENCE

LAID BEFORE THE

HEALTH OF TOWNS COMMISSION

AND THE

Select Committee of the House of Commons

ON

METROPOLITAN SEWAGE MANURE;

TOGETHER WITH

EXTRACTS FROM WORKS OF AUTHORITY,

SHEWING THE

VALUE OF THE REFUSE OF TOWNS,

AND THE ADVANTAGES IN A SANATORY POINT OF VIEW OF
ITS APPLICATION IN A LIQUID FORM TO

AGRICULTURAL PURPOSES.

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ADVERTISEMENT.

This Analysis of Evidence was originally prepared for, and published by, the Metropolitan Sewage Manure Company. Having been placed at the disposal of the Health of Towns' Association, the Committee have caused such alterations to be made in it as were necessary to fit it to form one of their series. It will be found to comprise some of the most important facts relative to one part of the great scheme of sanatory improvement—the application of the refuse of towns, suspended in water, to the purposes of agriculture. The Committee have also caused a form of petition for landowners, agriculturists, market gardeners, &c., to be drawn up and appended to the analysis.

FORM OF PETITION*

FOR

LANDOWNERS, AGRICULTURISTS, MARKET GARDENERS,

&c. &c.

That your Petitioners are Landowners, Farmers, and Market Gardeners, owning and cultivating land within miles of the town of

That it is of the first importance to your petitioners to obtain a large supply of manure.

That such a supply of manure is to be found in the refuse of our towns, the greater part of which, in consequence of the expense of conveyance in the solid form, is now wasted: but that in the liquid form, in which it exists in the contents of the sewers, it can be most cheaply conveyed, and most economically applied.

That the sanatory measure about to be brought forward by the Government, by combining an ample supply of water with a good system of house and street drainage, would increase the supply of this valuable manure. Your petitioners are therefore directly interested in the success of that measure, and pray that it may be taken into immediate consideration, and passed with as little delay as possible.

And your petitioners will ever pray.

* The Petition to the House of Lords should be addressed, "To the Right Honorable The Lords Spiritual and Temporal of the United Kingdom of Great Britain and Ireland, in Parliament assembled." That to the House of Commons should be addressed, "To the Honorable the Commons of the United Kingdom of Great Britain and Ireland, in Parliament assembled."

ANALYSIS OF EVIDENCE, &c.

THE present mode of cleansing and draining our large towns, and disposing of their refuse, will doubtless be regarded by the next generation with the same feelings of surprise with which we view the strange customs of barbarous people. It is a striking example, on the grandest scale, of inefficiency and extravagance. We shall search in vain for a similar instance of wholesale waste of resources. Not content with polluting our rivers, and heaping up upon their banks masses of offensive matter most injurious to health, we are constantly pouring into them treasures which cannot be estimated at a less sum than several millions a-year. In the metropolis alone, the value of the liquid refuse annually carried into the Thames, and lost to agriculture, amounts, according to the very lowest estimate, to half a million pounds, and according to the highest to little short of four millions.

To improve the drainage of our towns, to restore the waters of our rivers to their purity, to put a stop to the poisonous exhalations which are constantly rising from their banks, and to apply the valuable refuse which now runs to waste to the purposes of agriculture, are objects, the importance of which it is difficult to exaggerate.

As the application of liquid manure to agricultural and horticultural purposes, though by no means unknown to the ancients, and long practised in many parts of Europe, and for a still longer period, and more systematically, in China, has not yet come into general use in England; it has been thought that an Analysis of the valuable Evidence recently

laid before the Health of Towns Commission, and before the Select Committee of the House of Commons on Metropolitan Sewage Manure, together with extracts from works of authority, might prove useful, both by promoting the cause of Sanatory Reform, and by imparting instruction to the agriculturist on a subject of great and growing importance.

The principal results established by the quotations contained in the following analysis may be briefly stated thus :—

1. The very substances which, if allowed to collect and decompose in the midst of our large towns, give rise to fevers and other destructive diseases, may be made the source of great fertility to the surrounding country. p. 4.

2. These same substances, diluted with water, may be conveyed into the country and applied to the land with perfect safety, and less offensively than the solid manures now in use. p. 5.

3. The state of dilution in which the refuse of towns exists in the Sewer Water, is highly favourable to the growth of plants, and the increase of the fertility of the soil. p. 6.

4. The Sewer Water, which it is thus proposed to apply to the purposes of agriculture, is proved, by chemical analysis, to contain all the elements of fertility. p. 7.

5. It has a high money value. p. 11.

6. From very accurate experiments on the relative fertilizing power of different kinds of manure, it results that an equal produce may be raised by liquid manure at a far cheaper rate than by any other manure, whether domestic or foreign ; and that liquid manure is consequently by far the most economical that can be made use of. p. 13.

7. Though the employment of liquid manure is, as yet, by no means general, instances of increased produce attending its use are on record, and very striking illustrations have been afforded of the increased value which it gives to land. p. 15.

8. Sewer Water has been advantageously applied, both to pasture, arable, and garden ground, and with the very best effects to a vast variety of produce. p. 18.

9. There is every reason to believe that the Sewer Water will be in large and constant demand at every season of the year. p. 23.

10. There are also certain incidental advantages attending the use of liquid manure, such as a more rapid

growth of the plants watered by it, and the destruction of some kinds of insects. p. 27.

11. It is admitted on all hands that the value of the liquid manure is such as amply to repay the expense of its conveyance. p. 27.

12. It is also proved that the conveyance by pipes is much more economical than any other means of transport; for on comparing the relative expense of conveying solid and liquid manure, we arrive at the important conclusion, that the cost of conveying the liquid manure by pipes is perfectly insignificant as compared with the cost of the transport of solid manure by carts; while the cost of distributing the liquid manure over the land is but a fraction of the expense attending the application of solid manure.

13. The practicability of this plan of conveying and distributing the refuse of towns is proved by experiment. p. 29.

It is not pretended that the subject of the application to agriculture of the liquid manure, as collected from the sewers of large towns, is exhausted by the following analysis; but it is confidently expected that the considerations brought forward will suffice to prove the enormous value of that which is now allowed to run to waste, the entire feasibility of the plan proposed for its collection and distribution, and the consequent obligations under which the advocates of sanatory reform are placed to promote its adoption. So great a saving, so great a boon to the inhabitants of the metropolis, and to the agriculture of the surrounding districts, must receive the cordial support of the public, alive to the vast importance of providing, by a system of wise economy, for the rapid increase of our already crowded population. An annual addition to our population of 300,000 inhabitants cannot but excite the most lively apprehensions, if we continue a system of wasteful extravagance, by which the richest elements of fertility, having an acknowledged value of several millions a-year, are constantly being thrown into the sea. Unlike all other sources of manure, the refuse of towns bears a constant relation to the increase of population, and promises a perennial supply of fertilizing matter, which not only cannot fail, but must be continually on the increase.

1. *The very substances which, if allowed to collect and decompose in the midst of our large towns, give rise to fevers and other destructive diseases, may be made the source of great fertility to the surrounding country.*

The bane of the town is the boon of the country.

"The very refuse of the materials which have served as food and clothing to the inhabitants of the crowded city, and which, if allowed to accumulate there, invariably and inevitably taint the air, and render it pestilential, promptly removed and spread out on the surface of the surrounding country, not only give it healthfulness, but clothe it with verdure, and endue it with inexhaustible fertility."—*Dr. Southwood Smith's evidence before the Health of Towns' Commission.* First Report, p. 79.

This cause of disease if properly conveyed and applied to the country would promote abundance, cheapen food, and increase the demand for beneficial labour.

"The condition of large rural districts in the immediate vicinity of the towns, and of the poorest districts of the towns themselves, presents a singular contrast in the nature of the agencies by which the health of the inhabitants is impaired. Within the towns, we find the houses and streets filthy, the air fetid; disease, typhus, and other epidemics rife amongst the population; bringing, in their train, destitution and the need of pecuniary as well as medical relief; all mainly arising from the presence of the richest materials of production, the complete absence of which would, in a great measure, restore health, avert the recurrence of disease, and, if properly applied, would promote abundance, cheapen food, and increase the demand for beneficial labour. Outside the afflicted districts, and at a short distance from them, as in the adjacent rural districts, we find the aspect of the country poor and thinly clad with vegetation except rushes and plants, favoured by a superabundance of moisture, the crops meagre, the labouring agricultural population few, and afflicted with rheumatism and other maladies, arising from damp and an excess of water, which, if removed, would relieve them from a cause of disease, and the land from an impediment to production; and, if conveyed for the use of the town population, would give that population the element of which they stand in peculiar need, as a means to relieve them from that which is their own cause of depression, and return it for use to the land as a means of the highest fertility."—*General Report on the Sanitary Condition of the Labouring Population of Great Britain.* 1842. p. 97.

Our present supply of

"The most effectual, as well as the most economical method of restoring the balance between the town and

country, would be to avail ourselves of that enormous accumulation of animal exuviæ which the existence of a crowded city necessarily occasions; and to convert that which is now a pabulum of disease into a source of life and abundance.

guano an imperfect substitute for the wasted manure of our towns.

"As indeed the geologists of the present day cite, as a proof of the ignorance or neglect of their predecessors, that the stone required for the fortifications at Gibraltar was brought out from England, when it might have been obtained upon the very spot; so I conceive our descendants will marvel at the inattention to chemical science evinced by the present generation of farmers, in importing from distant regions, such as South America, substitutes, and those perhaps but imperfect ones, for that fertilizing material, of which the greater part is allowed to deposit itself unprofitably in the beds of our rivers."—*On the Application of Science to Agriculture, by C. Daubeny, M.D., F.R.S. Journal of the Royal Agricultural Society.* 1842.

Waste of phosphates.

"Thousands of hundred-weights of those phosphates flow annually into the sea, with the Thames and with other of the British rivers."—*Liebig's Chemistry of Agriculture, &c.*

Source of the fertility of Belgium.

"It is to the use of this substance (town refuse) drawn from reservoirs in the towns, that Belgium, in a great degree, owes her fertility; while in many large cities of Germany, it is allowed to drain into the rivers. Since 1200 pounds' weight of it yearly may be reckoned for each unit of population, it is easy to see, where population is counted by millions, how important its application must be."—*Professor Sprengel, on Animal Manures. Journal of the Royal Agricultural Society.* 1840.

2. *These same substances, diluted with water, may be conveyed into the country and applied to the land with perfect safety, and less offensively than the solid manures now in use.*

The offensive odour of Sewer Water due chiefly to the solid deposits.

"I observed, on going over the meadows (in the neighbourhood of Edinburgh) so irrigated with the Sewer Water, that the offensive smells complained of by some of the neighbouring inhabitants, as arising from the meadows, emanated mainly from the masses of decomposing matter left in the ponds, and not so much, if at all, from the water holding only fertilizing matter in solution."—*Evidence of James Smith, Esq., of Deanston. Health of Towns' Commission.* Part ii., Appendix, p. 325.

Sewer Water, in its worst state less offensive than common farm-yard manure.

"Even in its worst condition it (the Sewage Water) smells much less than the common farm-yard manure does, and being in a liquid state, it will be immediately absorbed into the soil; if there is any smell, it will be very evanescent."—*Evidence of James Smith, Esq. of Deanston. Report of the Select Committee on Metropolitan Sewage Manure*, p. 6.

Idem.

"I imagine that this Sewage Water is a much less noxious and fetid manure, than many others in present use."—*Professor Brande's evidence. Ibid.* p. 55.

No sulphuretted hydrogen generated, if the Sewer Water is applied in the recent state.

"I do not think, if it were dispersed over the surface of the earth so as to be imbibed and soaked into the soil, that any sulphuretted hydrogen would be generated. It is merely where it is kept stagnant and in quantity, and where the organic matter has an opportunity of decomposing in contact with the solution, that the production of sulphuretted hydrogen ensues." *Ibid.* p. 56.

The odour disappears in half an hour.

Mr. J. Knight, in answer to the question, "How soon does the smell go off after the use of it?" says, "I think you find very little of it, perhaps, in half an hour." *Ibid.* p. 48.

3. *The state of dilution in which the refuse of towns exists in the Sewer Water is highly favourable to the growth of plants, and the increase of the fertility of the soil.*

Dilution lessens the odour, and increases the value of the manure.

Dr. Lyon Playfair, speaking of some imperfect attempts to apply the refuse of towns, made in the case of Preston and Bury, says:—"This," the failure of the attempts, "is mainly owing to the want of dilution of the refuse, which not only would prevent the escape of odour, but also render the manure more fit for reception by the plants."—*Evidence before the Health of Towns' Commission.* Part ii., Appendix, p. 46.

The chief difficulty at Edinburgh, the want of water to dilute the Sewerage.

I had a correspondence with Mr. Oliver, a very scientific agriculturist who unfortunately is no more, one of the most able men in Scotland, who had a portion of the irrigated meadows near Edinburgh, and he stated that their great difficulty was the want of water, the means of dilution. It appeared, when I visited Edinburgh, from the testimony of better judges, because practical judges, that that was about their chief difficulty, getting a command of water to dilute and apply the Sewer Water with the best effect. When the Sewer Water was first run on, it appeared to be (as the Duke of Portland described to me the

water on his irrigated meadows), of the consistency of "turtle soup;" after it had run over about 40 acres, and had deposited the matter in suspension, it appeared to be as transparent nearly as toast and water. The grass at the extremity of the irrigation, where the liquid manure is in this last condition, appears to be of a finer and better quality. If they could have obtained the free command of plain water, they would probably have used it to dilute the Sewer Water, and apply it in the diluted state more frequently.—*Evidence of E. Chadwick, Esq. Report of Select Committee of the House of Commons, on Metropolitan Sewage Manure*, p. 109.

Land irrigated by Sewer Water free from deposit, produces the best grass.

"The more you dilute, the more you gain in efficiency within some limit as yet unascertained." *Ibid.* p. 109.

Virtue of dilution.

"Certainly that extent of dilution that prevents the escape of any offensive emanations, indicates the best state in which the manure is preserved, and the state in which it is best applied." *Ibid.* p. 109.

Idem.

"The high tide flows up a great way to the Hammersmith road, and beyond that; and the market gardeners let a great quantity in of the water from that creek, and they take care to let it in at the time the tide rises, which is bringing up all the drainage from London; and they use it to a great extent; in fact, they saturate the earth with it, and with such effect that they seldom use a water-pot." —*Mr. Knight's evidence, ibid.* p. 50.

When diluted by the water of the river, highly productive.

"In so far as my experience of the application of Sewer Water goes, I think that Sewer Water could stand considerable further dilution."—*Evidence of James Smith, Esq., ibid.* p. 64.

The Sewer Water will bear further dilution.

"If we had the Sewage water as it comes from the houses, it would be much too strong; we are the better for the water."—*Ibid.* p. 4.

Too strong as it comes from the houses.

4. *The Sewer Water which it is thus proposed to apply to the purposes of agriculture is proved by chemical analysis to contain all the elements of fertility.*

"These salts, as they are derived in great measure from the excretions which have passed into the sewer, are principally composed of the ashes of our bodies, resulting from the food we have digested; and as we have received these salts either directly from plants, or indirectly through animals from plants, it is evident they must be the food of plants; and plants receive these substances from the soil,

Source of the contents of the Sewer Water.

which they must gradually exhaust. Now, amongst these substances, we find three which are especially valuable to plants; of these three, the most important is ammonia; ammoniacal salts exist in these waters to a considerable extent:—and in addition to these, we have alkaline salts, potash, and common salt; potash is not so abundant as common salt:—and in the third place, earthy phosphates, containing the whole phosphoric acid. I mention these three compounds in particular, because they are substances that are found in the soil in but small quantities, and yet are absolutely essential to the maintenance of vegetable life. The quantity of potass which passes out of this sewer per day (estimating the average discharge of the sewer at about thirty gallons in a second, so that the average daily discharge would be about two millions and a half of gallons), the average quantity of potass would be about a ton weight, and about the same quantity of phosphates of the earths pass off every day; *i. e.*, about a ton of phosphoric acid, in combination with lime and magnesia, emptied from this sewer every day in waste. Of ammonia there is more than that, nearly double that quantity, nearly two tons of ammonia. The two analyses differ in some respects; the ammonia varies. In one case I find about a ton, and in the other about two tons per diem. In the case where the water was stopped by flood-gates, which I consider the fairest average of the two, I find as much as two tons turned out into the Thames per day; the quantity will vary according to the season."—*Evidence of Professor Miller, of King's College. Report of Select Committee on Metropolitan Sewage Manure, p.* 38.

The quantity of potash, phosphates, and ammonia, daily passing into the Thames from the King's Scholars' Pond Sewer: Potash 1 ton, phosphates 1 ton, ammonia 1 or 2 tons.

An analysis of one average specimen of Sewer Water, by Dr. Miller, gave the following results:—

Matters in solution and suspension in the water of the King's Scholars' Pond Sewer.

Matters in solution, per gallon, 45 grains, 9 tenths.
Matters in suspension, ditto, 44½ grains.

A second average specimen, examined by Dr. Miller, gave a larger proportion of both constituents.

A specimen of Sewer Water collected at four different times of the day, from the King's Scholars' Pond Sewer, analyzed in the laboratory of King's College, gave the following results:—

Matters in solution, per gallon, 80 grains.
Matters in suspension ditto 1000 grains.

A specimen examined by Messrs. Brande and Cooper was found to contain—

Matters in solution, per gallon . 85 grains.
Matters in suspension, ditto . 55 grains.

An analysis of the Sewer Water of Edinburgh, made by Mr. Philips, of the Museum of Economic Geology, gave— Edinburgh Sewerage.

Solid matters in solution . . 83 grains.
Solid matters in suspension . 244 grains.

An analysis of the same water, by Mr. J. T. Cooper, gave—

Matters in solution . . . . 78 grains.
Matters in suspension . . . 79 grains.

Mansfield undiluted sewage was found to hold 77 grains of matter in solution. Mansfield Sewerage.

From this comparative analysis, it may safely be inferred that the sewage of the King's Scholars' Pond Sewer is as rich in soluble matters—to which, mainly, the sewage water owes its value—as the sewerage of Edinburgh or Mansfield, from which such surprising results have been obtained (See p. 15).

The following minute analyses will show the substances held in solution and suspension:—

KING'S SCHOLARS' POND SEWAGE (AVERAGE).

Analyzed by Messrs. Brande & Cooper.

One gallon of the liquid portion, evaporated to dryness, gave 85·3 grains of solid matter, 74·8 of which was again soluble, containing— Analysis of Messrs. Brande and Cooper.

Ammonia	3·29
Sulphuric acid	0·62
Phosphate of lime	0·29
Lime	6·05
Chlorine	10·00

and potassa and soda, with a large quantity of soluble animal and vegetable matter. And 10·54 was insoluble.

The insoluble portion, produced by evaporation of the liquid, weighed 10·54, and consisted of—

Phosphate of lime	2·32
Carbonate of lime	1·94
Silica	6·28
	10·54

The deposit from a gallon weighed 55 grains, of which 21·22 grains were combustible, and consisted of animal matter rich in nitrogen, some vegetable matter, and a quantity of fat; and 33·75 of matter, consisting of—

Phosphate of lime	6·81
Oxide of iron	2·01
Carbonate of lime	1·75
Sulphate of lime	1·53
Earthy matter and sand	21·65
	33·75

KING'S SCHOLARS' POND SEWAGE (AVERAGE).

Analyzed by Professor Miller.

Professor Miller's analysis.

Ammonia	3·26
Phosphoric acid	0·44
Potash	1·02
Silica	0·54
Lime	7·94
Magnesia	1·87
Common salt	13·66
Sulphuric acid	7·04
Carbonic acid	4·41
Combustible matter, containing 0·34 nitrogen	5·80
Traces of oxide of iron	—
Matters in solution . . .	45·98
Matters in suspension consisting of combustible matters, sand, lime, and oxide of iron	44·50

5. *The Sewer Water has a high money value.*

Value of the Sewage Water which flows into the Thames from the King's Scholars' Pond Sewer.

Ammonia in a state of salt is worth, at the lowest computation, 16*s.* a cwt. Now, upon the low computation that only one ton of ammonia (which is equal to three tons of any salt of ammonia) passes off into the Thames each day from this sewer, 48*l.* worth would be thrown away; in the same way, about a ton of earthy phosphates, or bone earth, the commercial value of which is not less than 3*l.* a ton; say the same for the potash thrown off; we shall have 54*l.* worth passing off every day, actual money value. The quantity of solid matter in suspension, say it amounts even to double the quantity I have found (I have found nearly 50 grains per gallon), say 100 grains, would yield daily about 16 tons (of course taking for granted that the calculation of the delivery of this sewer is correct); it would yield daily 16 tons of solid matters in suspension, which at 10*s.* per ton would be worth only 8*l.*; so that we have for the liquid manure an excess of value of 46*l.* over the solid.

The daily loss is 54*l.* for the liquid; and the total loss would be about 64*l.*

Annual value of its chief constituents, £23,360.

(According to this calculation, the annual value of the chief constituents of the Sewage Water, which at present passes into the Thames from the King's Scholars' Pond Sewer, is £23,360; and of that which flows from all the Sewers of London, on the supposition that the fluid they discharge is of equal strength, £433,879.)—*Evidence of Professor Miller. Report of Select Committee*, p. 41.

The excretions of one man valued at £1 17s. a year.

"Human excrements contain (with the exception of one ingredient, silicate of potash) all the conditions essential to fertility. . . . In fact, when we recollect that a pound of urine contains all the ingredients necessary for the production of a pound of wheat, it seems incredible folly to allow all the valuable refuse to run to waste in our large towns, and to send whole fleets to Ichaboe and the Incas, for what we are wasting at home. In Flanders, where much manure is used, the collected excrements of a man for one year are valued at 1*l.* 17*s.*"—*Dr. Lyon Playfair. Health of Towns' Commission.* Part ii., Appendix, p. 47.

The Sewer-Water of towns calculated to yield a clear revenue of £1 a head.

"Taking a general view of the subject, we may assume a clear revenue from the Sewer Water of all towns of 1*l.* for each inhabitant, either in a direct money return, or partly to the inhabitants in a reduced price, from the increased abundance of produce."—*Evidence of J. Smith, Esq., of*

Deanston. Health of Towns' Commission. Part ii., Appendix, p. 328.

Saving due to Sewer Water as compared with guano or farm-yard manure.

"I have ascertained that the quantity of Sewer Water due to a town of 50,000 inhabitants amounts to about 1,190,080,946 gallons per annum, which quantity will yield an annual application of 17,920 gallons per acre to an extent of 66,410 acres. Taking the average cost of guano and farm-yard manure at *2l.* per acre, and deducting 12*s.* 9*d.*, the cost of the application of the Sewer Water, there will appear a saving due to the Sewer Water of 1*l.* 7*s.* 3*d.* per acre; allowing one half thereof to go to the farmer, there will remain a free income due to the Sewer Water of 45,241*l.*, which is nearly 1*l.* per head of the population."—*Evidence of James Smith, Esq., of Deanston. Report of the Health of Towns' Commission.* Part ii., Appendix p. 328.

The night-soil a valuable perquisite in Belgium.

"I entertain no doubt, that when administrative improvements admit of sanatory arrangements being carried out, it may be worth while to pay the householder at the least 10*s.* a head for the refuse of his house, instead of half-a-crown, as the farmer does. I think they pay him—the highest price I have heard has been something like 10*s.* for the refuse of a house, he carting it away; and I believe, either in rates or rents, 10*s.* a head might be paid. The truth is, in Belgium for the solid manure they pay as much as 1*l.* 17*s.* per head—for the liquid and solid manure of an adult. At Bruges, I found that it is considered a very valuable perquisite. I was told a housemaid of all work might be got for 3*l.* a year wages, and the night soil."—*Evidence of E. Chadwick, Esq. Report of the Select Committee of the House of Commons on Metropolitan Sewage Manure*, p. 111.

The sandy wastes of Flanders and Holland fertilized by the refuse of towns.

"The London drainage would be most valuable; we should be independent of all the guanos or foreign manures, if we could obtain it in anything like a concentrated form. Flanders and Holland thrive in the most marvellous manner, owing entirely to that; they are fertilizing every year several thousands of acres of floating, blowing sand, which becomes compact, and produces the most abundant crops of potatoes, and afterwards corn of every description. It is, in fact, the best and most important manure that I am acquainted with, containing all the elements that Liebig tells you that land requires under different sorts of cultivation."—*Dr. Granville's Evidence.* Ibid. p. 69.

"The city of Paris gets a clear revenue of 800,000 francs from the right of allowing certain persons to empty and carry away the night-soil, which is conveyed to Montfauçon."—Ibid. p. 67.

The refuse of Paris a source of revenue to the city.

"The solid substances contained in urine, if all added to the land, would be more fertilizing than guano, which now sells at 10*l.* a ton. If we estimate the urine of each individual on an average at only 600 pounds, then there is carried into the common sewers of a city of 1,000 inhabitants a yearly weight of 600,000 pounds, or 270 tons of manure, which at the present price of guano is worth £2700; which would no doubt prove more fertilizing than its own weight of guano, and might be expected to raise an increased produce of not less than 1,000 quarters of grain."—*Johnson's Lectures on Agricultural Chemistry.*

Urine more fertilizing than guano.

6. *From very accurate experiments on the relative fertilizing power of different kinds of manure, it results that an equal produce may be raised by liquid manure at a far cheaper rate than by any other manure, whether domestic or foreign; and that liquid manure is consequently by far the most economical that can be made use of.*

"A Mr. Thompson, at Clitheroe in Lancashire, was induced to fit up a small pumping apparatus; he has a village there and a bleach work, where there is a great deal of soapsuds and sewage matter from the village generally. At my recommendation, he fitted up pumps, and with pipes conveyed it over his pasture land; and in order to test before he had gone on with his operations what was likely to be the result, he applied eight tons of liquid manure to a given extent of land, to an acre; to another acre he put fifteen tons of common farm-yard manure in the usual way of dressing; to another acre he put a quantity of guano—three cwt. of guano. The result was, that the grass which was raised by this Sewage Water was superior to the grass raised either by the guano or by the common farm-yard manure, fifteen tons against eight. It must be taken into account that the liquid manure which he used was better than the common Sewage Water."—*Evidence of James Smith, Esq. of Deanston. Report of Select Committee on Metropolitan Sewage Manure*, p. 13.

Eight tons of liquid manure (soapsuds and sewage matter) superior to *fifteen* tons of farm-yard manure, and *three* cwt. of guano.

"I had another set of experiments made at Stirling, which gave very interesting results. I employed a person there upon whom I could rely to make the experiment for

Results of a similar comparison at Stirling.

me. He laid out some land in rather a sandy loamy soil; laid out portions; first a division he manured with farm dung and ashes mixed, at the rate of 12 tons per acre, and at a cost of 48*s*. A second portion, with the same compost, giving 16 tons per acre, and at a cost of 64*s*. A third division, with guano, 2 cwt., costing 16*s*. A fourth with guano, 4 cwts. per acre, at a cost of 32*s*. Another ridge, similar in extent to the whole of this, was manured with Sewer Water, at the rate of 16 tons per acre, and taking it at 3*d*. per ton, the cost would be 4*s*. The average produce (the different specimens were not ascertained separately), the average produce of the whole variety, the dung and guano averaged 45 bushels per acre of good barley. That with the Sewage Water averaged 42 bushels per acre, showing that this small quantity of 16 tons had the effect of coming very nearly up to the dung and the guano, but showing also that more liquid manure might be given with safety. There was a small piece tried without manure at all. The piece tried without manure only gave 30 bushels. The section which was raised from the 16 tons of mixed manure, and from the 4 cwt. of guano, both of them were rather overgrown, and were laid in consequence of their great growth. That which was raised by the Sewage Water was not so heavy as to be laid; but it approximated very nearly to the bulk of the others."—Ibid. p. 13.

Relative cost of Sewer Water and Guano.

"Two-and-a-half cwt. of guano, applied annually to an acre of land, would induce a very rich condition of the soil, especially when conjoined with the farm-yard manure always available, and would even tend, in a course of years, to increase very much the amount of this description of manure. Taking the quantity of water necessary, from analysis, to furnish 5 cwt. of fertilizing matter, at 17,920 gallons per acre, I give below an estimate of the cost thereof; I give also an estimate of the cost of supplying double that quantity, equal to 5 cwt. per acre of guano or 30 tons of farm-yard manure.

Cost of manuring one acre with Sewer Water .	0	12	9
Ditto with Guano, $2\frac{1}{2}$ cwt. at 8s.	1	0	0
Ditto with farm-yard manure, 15 tons at 4s. .	3	0	0
Sewer Water is cheaper than Guano	0	7	3
Ditto than farm-yard manure	2	7	3
Ditto than the average of the two	1	7	3

Cost of manuring one acre with Sewer Water .	0	16	6
Ditto with Guano, 5 cwt. at 8s.	2	0	0
Ditto with farm-yard manure, 30 tons at 4s. .	6	0	0
Sewer Water is cheaper than Guano	1	3	6
Ditto than farm-yard manure	5	3	6
Ditto than the average of the two	3	3	6

—*Evidence of James Smith, Esq., of Deanston. Report of Health of Towns' Commission.* Part ii., Appendix, p. 328.

7. *Though the employment of liquid manure is, as yet, by no means general, instances of increased produce attending its use are on record, and very striking illustrations have been afforded of the increased value which it gives to land.*

The following extracts refer to the city of Edinburgh :—

Application of Sewage to lands near Edinburgh.

"In the case of Edinburgh the increase of the value of poor lands thus irrigated, is shewn to have been from 30*s.* to 15*l.*, and, in some cases, to 20*l.* per acre; other lands, once let for 40*s.* to 50*s.* per acre, now let for very high sums. It is true, that the inhabitants around those meadows object to it as offensive; the value, however, of the irrigation is seen by the parties interested in about three hundred acres of land, estimating the compensation that would induce them to discontinue that practice at the sum of 150,000*l.*"—*Evidence of Mr. Roe, C. E. Health of Towns' Commission.* First Report, p. 407.

Increase of value from 30*s.* to 15*l.* or 20*l.* per acre.

"The practical result of this application of Sewer Water is, that land which let formerly at from 40*s.* to 6*l.* per Scotch acre, is now let annually at from 30*l.* to 40*l.*; and that poor sandy land on the sea shore, which might be worth 2*s.* 6*d.* per acre, lets at an annual rent of from 15*l.* to 20*l.* That which is nearest the city brings the higher rent chiefly because it is near and more accessible to the points where the grass is consumed, but also partly from the better natural quality of the land. The average value of the land, irrespective of the Sewer Water application, may be taken at 3*l.* per imperial acre, and the average rent of the irrigated land at 30*l.*, making a difference of 27*l.*; but 2*l.* may be deducted as the cost of management, leaving 25*l.* per acre of clear annual income due to the Sewer Water."—*Evidence of James Smith, Esq. of Deanston. Report of the Health of Towns' Commission.* Part ii. Appendix, p. 326.

Increase of value from 2*l.* and 6*l.* to 30*l.* and 40*l.* per acre. Also from 2*s.* 6*d.* to £15 and £20. per acre.

Average original value £3, average value after irrigation with Sewer Water, £30; difference, £27. Clear annual income due to Sewer Water, £25.

Lowest value, £20; average, £40.

"The lowest sum obtained per Scotch acre for meadow land in the vicinity of Edinburgh, irrigated with the refuse of that town, is 20*l.*, and the average amounts to about 40*l.*"—*Evidence of Dr. Lyon Playfair.* Ibid., Part ii. Appendix p. 46.

The value of the drainage of London exceeds £500,000 a year.

"The value of town manure may be estimated by the fact, that a portion of the drainage of Edinburgh spread upon certain level lands towards the sea has increased the value of these lands by more than 5,000*l.* a year; and that, if the whole drainage of London could be so used, at a sufficient distance from the town, the value would exceed 500,000*l.* a-year. Now engineers, who pump from the Thames many miles above London to supply pure water to the inhabitants, could as easily, by pumping away to any desired distance the fluid from the drains, supply the most valuable manure yet known (fluid town manure) to the horticulture and agriculture of the district; and the purity and beauty of the Thames, where it passes through London, would be preserved."—*Dr. Arnott's Report on the Fevers which have prevailed in Edinburgh and Glasgow*, p. 12.

Land so manured yields from three to six cuttings in the season.

"The *water containing the soluble parts is of great use*, and is carefully applied to the irrigating of grass-lands." "Such ground is annually kept in grass, and yields from *three to six cuttings* in the season."—*Extract from a letter of Mr. Thomas Oliver of Lochend, addressed to a Committee of Gentlemen appointed to Report upon Mr. Martin's Plan, printed* 1836.

"By this water (The Sewer Water of Edinburgh) about 150 acres of grass-land, laid into catch-work beds, is irrigated, whereof upwards of 100 belong to W. H. Miller, Esq., of Craigintinny, and the remainder to the Earls of Haddington and Moray, the heirs of the late Sir James Montgomery, and some small patches to other proprietors. The meadows belonging to the last-mentioned nobleman, and part of the Craigintinny meadows, or what is called the Old Meadows, containing about fifty acres, have been irrigated for nearly a century; they are by far the most valuable, on account of the long and continual accumulation of the rich sediment left by the water; indeed, the water is so very rich, that the proprietors of the meadow lying nearest the town have found it advisable to carry the common sewer through deep ponds, where the water deposits part of the superfluous manure before it is carried

over the ground. Although the formation is irregular, and the management very imperfect, the effect of the water is astonishing; they produce crops of grass not to be equalled, being cut from four to six times a-year, and given green to milch cows. The grass is let every year by public auction, in small patches, from a quarter of an acre and upwards, which generally brings from 24*l.* to 30*l.* per acre. This year (1826) part of the Earl of Moray's meadow gave as high as 57*l.* per acre."—*From Mr. George Stephen's Essay on Irrigated Meadows, published in* 1826, pp. 72, 73.

Four to six crops of grass a year.

The grass let at from £24 to £30 an acre, and in one instance as high as £57.

"There is a letter to me from the late Mr. Oliver, a man who rented some blowing-sand in the neighbourhood of Edinburgh, and who, by making the drainage of Edinburgh pass over it, fertilized it to that extent that he actually grew grass through the winter nearly, which he sold at so much an acre by auction, generally fetching 20*l.* or 25*l.* I went to see him, and I lived two days with him, and ascertained the fact. In the letter I have referred to, he says, "I care nothing for the solid; I would not give a fig for all they could give me at Edinburgh." He says, "The only valuable part is the supernatant liquid."—*Evidence of James Smith, Esq. Report of Select Committee.*

The solid matter of no value. The only valuable part is the supernatant liquid.

"Some of the meadows irrigated by the Sewage Water of Milan yield a net rent of 11*l.* per *tornatura* (a measure of 10,000 square metres, equal to about two acres and a half), besides a land-tax of 61 francs 10 cents, the expenses of administration, repairs of buildings, &c. These meadows are mowed in November, January, March, and April, for stable feeding; in June, July, and August they yield three crops of hay for the winter; and in September they furnish an abundant pasture for the cattle, till the beginning of the winter irrigation."—*First Report of the Health of Towns' Commission.* Vol. ii. p. 403.

Application of Sewage at Milan. Seven crops of grass a year besides pasturage.

The value of this mode of Agriculture has also been proved on an extended scale, in the Duke of Portland's water meadows at Clipstone Park. The course there pursued has been chiefly one of irrigation, the water being but slightly imbued with Sewage Manure. It is, however, a striking illustration of the still greater advantages obtainable from Sewage Manure itself.

The Duke of Portland's water meadows at Clipstone Park.

"The land immediately occupied by these meadows was, in its wild state, a line of hill-sides covered with gorse and heather—a rabbit warren, over which a few

sheep wandered—and a swampy valley below, thick set with hassocks and rushes, the favourite haunt of wild ducks and snipes; through which the little stream, the Maun, wound its way in its descent from the town of Mansfield.

"The whole tract, both upland and lowland, was of very little value. The valley was in many parts from nine to ten feet deep in bog, and almost worthless; the hill-sides varied in quality, but 80*l.* a-year would have been a full rent for the 300 acres. Indeed the whole of the Clipstone Park Farm when taken in hand in the year 1816, containing 1,487 acres, had been let for the sum of 346*l.*

Increase of value from 4*s.* 6*d.* to £11 4*s.* per acre.

"The effect of this irrigation has been to raise the annual value of this land from 4*s.* 6*d.* to 11*l.* 4*s.* per acre." —*Journal of the Royal Agricultural Society of England.* Vol. i. 1840, p. 356, 367.

In Dumfriesshire, the value of land raised from £4 to £15, and £20, by irrigation with Sewer Water.

"I met with a small instance last year in going through Dumfriesshire, and passing a little town there, in valuing the land for a railway, some little meadows and parks of ground in the immediate vicinity of the town, worth about 4*l.* an acre; I came to one that I found in a more enriched state, and looking about I found the Sewage Water from the town came upon it; I was rather in a difficulty to know what value to put upon it. I went and investigated the matter; I got the people who rented it; they were paying from 15l. to 20l. an acre for that land, and the same land elsewhere was worth about 4l.; this I was obliged to put down in my valuation as worth from 15l. to 20l."—*Evidence of Mr. W. G. Jolly*, p. 99.

8. *Sewer water has been advantageously applied both to pasture, arable, and garden ground, and with the very best effects to a vast variety of produce.*

Pasture.

Mr. James Norris, market gardener, Sion Hill, Isleworth, in answer to the question, "Have you used Sewage Water at all?" says—"Yes, a great deal of it; we have used it for some time, on the meadow land principally; little, in fact none, on the garden land; we have not had enough of it. It is the drainage of the yards. We draw a great deal of manure from London, in the waggons; that lies in large heaps: every fall of rain that comes upon it drains it away into a large hole; when full we draw it away in water-carts, and water the meadows. We have had a very great effect

this year; I think the greatest crop I ever saw on a field we have been dressing."—*Report of Select Committee*, p. 50.

"I may also mention another experiment made upon a farm at Glasgow, where the liquid manure was put over the land, and the growth has continued during the whole winter in a very remarkable way. No doubt the last season has been a remarkable season for grass everywhere; but notwithstanding that, this was distinguished before all the grass of the country round. I saw, about the 1st of December, 43 Irish bullocks wading to the fetlocks in grass upon some of these fields, and eating it most greedily, while the fields upon the farms in the neighbourhood were perfectly bare. I have a report with regard to its progress this year, and the advance of the grass has been very remarkable throughout. The proprietor, although requiring the greater part of the grass for his own use, has let a part of it to see what it will bring. He has got for it (land he could not before have let for more than perhaps a couple of pounds) 8*l.* this year. He considers it to be let very much below its value; so much so, that having given notice of a public sale, he stopped it, expecting, of course, to make more of it by keeping it himself."—*Evidence of James Smith, Esq. of Deanston.* Ibid., p. 15.

Increase of value from £2 to £8 an acre.

"A gentleman near Dumfries has made a tank, into which he has carried all the water from his farmstead and his house, the sewage of his house, and also has put in some solid manure, and has applied water to it; and just with a common pump, which is worked by two men, he has been, during the whole of this winter, irrigating his lawn, and he says he has the most beautiful flush of fine grass upon the lawn; and as the thing is done in the morning early, they have no annoyance whatever from any smell from throwing it upon the surface; and by doing it with the hose-pipe, he does not cut any notches in the ground: the smoothness and uniformity of the lawn is completely preserved."—*Ibid.*

Use of the Italian rye grass.

At the annual meeting of the Yorkshire Agricultural Society an interesting discussion took place on the preservation and application of liquid manure, when

"William Dickinson, Esq., of Willesden, near London, after strongly recommending the use of covered drains for the preservation of ammonia in liquid manures, stated that by the use of liquid manure he had last year produced ten crops of grass in succession upon the same land. The first was

Mr. Dickinson of Willesden.

cut in March, with about ten inches of grass; it was cut a second time on the 13th of April; a third time on the 4th of May; a fourth time on the 24th of May; a fifth time on June the 14th; a sixth time on July the 22nd, with ripe seeds, and three loads of hay straw to the acre. Immediately after each of these crops, the land was watered once from a London street water-cart, with two parts of urine from the stables, and one part of water; the produce of each crop increasing with the temperature, from three quarters of a load per acre as hay, to three loads per acre."

Mr. Dickinson's Evidence.

The following is an abstract of Mr. Dickinson's evidence before the Select Committee on Metropolitan Sewage Manure:—

Italian rye-grass.

It (the liquid manure from the stable) is conveyed to this tank, from which it is pumped into a water-cart, conveyed and mixed with two parts of water, if the temperature is as to-day; but if it were lower, we should mix it with one part of water; and in the winter season, we should put it on neat, to raise the temperature of the earth; the result of which has been, that I grew, the year before last, nine or ten crops of valuable grass, upon the same ground. The soil was a surface of clay, with a subsoil of clay, so bad that the Norfolk man said, "I would not have your farm as a freehold;" and the Lincolnshire man said, "I would not give you 12*s.* an acre for it, if it was at my own door." The first was less than three quarters of an acre; that was mown nine or ten times the year before last, in the course of twelve months. The grass increased in height as the temperature of the atmosphere. Some of these crops were three feet high, some of them more than three feet. They varied from ten inches or a foot, up to three feet six inches high. In the present year, in January, was cut the first crop, which weighed 2lbs. per yard, upwards of four tons per acre. The crop has increased in height every cutting since. The fifth is now growing upon the ground; the fourth is cut. I should say the second cutting was nearly twenty inches high. I did not weigh that; I should think it twice the weight of the other, or more than eight tons of the green grass. The third and fourth have been greater still.

Both in May and June the quantity of cuttings was beyond eight tons each time. If I were to state twelve tons, I should be within the truth, I am certain. This matter

is so often disbelieved, that I am rather cautious of saying what really does take place.

They (the oats and tares) were so wonderful after the grass, that I took them as samples to the agricultural show at Beverley; and the Yorkshiremen were astonished beyond measure at the grass report. Their argument was this: "You have exhausted your soil." I said, "I was aware that you would say so, and therefore I have brought the plants of the tares and the oats." The number of grains was astounding, so that there might have been in the earth the remains of the power of this urine used to the grass before. Oats and tares.

From 3,000 to 3,500 gallons of water are sufficient for an acre. I calculate 1,100 gallons of urine and 2,200 of water. Four acres kept 100 horses in grass-food till I was obliged to shut up my grass for seed. I have grown a yard of grass in twenty-one days.

"Mr Harvey, a gentleman of Glasgow, has applied it (Sewage Water) to some wheat land before the crop was sown, and he has had a luxuriant crop, more so than the other crops in the neighbourhood, and upon land which was rather cold, backward land."—*Evidence of James Smith, Esq. of Deanston. Report of Select Committee on Metropolitan Sewage Manure,* p. 35. Wheat.

"Mr. Machray, a coach proprietor of Aberdeen, took the Sewer Water of that town, catching it in an old barge, carrying it across the river, and pumping it into carts, and throwing it over his farm. The results were very great indeed; it was tried upon grass, barley, and turnips, and the superior crops raised from a small quantity of this sewerage water was remarkable."—*Ibid.* p. 17. Barley, turnips, grass.

"A second experiment was made in raising turnips upon a similar soil. Also at Stirling to the extent of a quarter of a rood, with two tons of Sewer Water, equal to 32 tons per acre, costing 8s., the produce 28 statute acres of bulbs; so that a ton of Sewage Water very nearly raises a ton of turnips."—*Ibid.* p. 13 Turnips.

"This person has also tried it upon some oats, and creditable persons who have inspected it agree in stating, that part of the oat-field dressed with this manure is very remarkable; the one is a full and fresh crop, and the other is very scanty and poor indeed. Last year, towards the end of the autumn, this person had a field of Swede turnips, which were looking very backward and had not taken well Oats, turnips.

with the manure; they did not come on well. He applied this liquid by running it by these pipes down between the drills. In three or four days after he had made this application, he applied it to the bottom of the drill (not upon a high-ridged drill, but the bottom), and the crop began to show symptoms of improvement immediately. I saw it at the end of the season, and a more bulky crop of Swedes I have not seen. He attributed it entirely to the application of liquid manure; he said if it had not been for that, he is sure, from the appearance of the plants, he should have lost the crop."—*Ibid.* p. 15.

Gardenground Mr. Wilmot's strawberries.

"In Kent, go where we will, we find the soil cart; the manure cart is in the background somewhere or other; they are unwilling to show it where they grow vegetables. They take the night-soil into Essex, they cart it twenty miles, then reduce it to liquid, and use it. I saw Mr. Wilmot's strawberries, which are well known at Isleworth, and he assured me (and I hope he will be examined as a witness here) that it was worth his while, his ground being at the back of the union house, and that draining upon his land, to make a tank there, and collect the refuse from the union house, cart it from thence upon the hill on the opposite side of the high road, and then water his plants with it; and the difference between the plants watered by that, and those manured in the ordinary way, is greatly in favour of the liquid manure; and if it would pay him to do it by such an expensive mode as that, there can be very little doubt about the result; of course, farmers could not afford to expend the same sum in labour."—*Evidence of W. C. Mylne, Esq. Report of Select Committee on Metropolitan Sewage Manure*, p. 27.

"I sank a well, and erected a privy over it for our men (who number from twenty to forty) to resort to. In this well I fixed a pump to get up the liquid matter, which, when diluted with water, I have found of great service to roses, peach-trees, and many other trees and plants whose names I am not at this moment prepared to enumerate."

Peach trees, roses, &c.

"All those plants termed "gross feeders" seem to delight in it. I think it particularly suits those of rather thickish fibre."

Roses, evergreen oaks.

"Roses in pots particularly; evergreen oaks, in pots, to which we apply this liquid manure, perhaps twice or three times a week, in a very strong state, without fear now at all."

"I am sure that for cabbage and lettuce, cauliflower, peas, beans, and French beans, and for all those things that have a great effort to make in a short time, and want a stimulus, it would be found one of the very best; an excellent stimulus."—*Evidence of Mr. J. Knight of Chelsea.* Ibid. p. 47.

Cabbage, lettuce, cauliflower, peas, beans, and french beans.

"I have known some instances, where the land has been favourably circumstanced, where the water has been applied to drill crops, such as peas, beans, and the usual garden products, with which it was very successful, especially with strawberries, producing more abundant crops, and much earlier than could have been obtained by any mode of top-dressing."—*Mr. James Dean, First Report of the Health of Towns' Commission.* Vol. ii., p. 406.

Peas, beans, strawberries.

9. *There is every reason to believe that the Sewer Water will be in large and constant demand at every season of the year.*

EVIDENCE AS TO THE DEMAND FOR THE SEWER WATER.

"We have done fifty acres of meadow; we do that with nothing but this drainage from the yard, and find it better on meadow land than solid. On garden land we have not tried it, only in one instance; we should be induced to try it to a great extent if it was cheap.

The Sewer Water likely to be in great demand.

"If it was delivered by cock, we should be induced to use an immense quantity, 100 tons to the acre a year, or more; 30,000 tons in a year."

"In answer to the question, 'Would you pay 2*d.* a ton?'—The witness says, 'Very glad to do it.'

"'Would you not be inclined to go half a mile with a cart?'—'We draw it more than half a mile now.'

"'Did you sign a petition in favour of this?'—'Yes, I did.'

"'Can you speak to any of the parties who have signed that in your neighbourhood?'—'I think that the people are all in favour of it; the large holders of land.'

"'All holders of land and market gardeners?'—'Yes.'

"'That you can speak to, that the large holders of land and market gardeners are in favour of some such measure as this?'—'Yes.'"—*Evidence of Mr. James Norris, Market Gardener, Sion Hill, Isleworth. Report of Select Committee,* p. 51.

The Sewage Water can be applied all the year round.

"By proper regulation, and with a little experience, the water can be disposed of all the year round. I am very well acquainted with irrigation and the various processes in agriculture; and looking at it with that experience and knowledge, I am satisfied that we shall find a regular and steady consumption for the water every day in the year."—*Evidence of James Smith, Esq., of Deanston.* Ibid. p. 8.

"What I chiefly wish to explain is the mode in which we can apply it during the whole season to tillage land. We will begin with the autumn, when the crops have been separated from the ground; it may be applied at the beginning to land to be in wheat; it may be applied during the whole winter, at any time that may suit the convenience of the farmer; to all lands in any condition, even stubble, or in furrow, or in grass, to be ploughed; that may be continued until past Christmas. Then after that I should say they would find an advantage in giving an application of the liquid manure to winter crops, to their wheats. Then land will be preparing for the spring crops, and that land can then get an additional quantity when it has been tilled and turned over. There would then be the coming of the spring crops; they would require some application to promote their growth after the plant is fairly fixed in the ground. Then there will be the preparation of land for potatoes; then follows the preparation of land for the turnips—a succession of turnip crops and vetches, and crops of that kind. Then part of the meadow land will have been cut for early hay; the hay would be possibly earlier when it is plentifully manured in this way than otherwise; all that hay would require the immediate application of Sewage Water to encourage its growth for the next crop. Then there would be a succession of hay crops during the summer, advancing to the end of July, according to circumstances, and according to the progress the crop has then made from its former cutting. Then from August there will be constant application; a second application of Sewage Water for promoting the growth of green crops, mangel wurzel, and all crops of that kind. That will go on taking advantage of the whole application that can be given until we come again to autumn, and commence again the same circle of application." Ibid. p. 25.

"I have no doubt the farmers will find it to be to their

advantage to have some store of it. I should say, instead of making dungsteads, as at present, in an open position and exposed to the atmosphere, when they come to know better the fact and advantages of using this liquid they will make their dungsteads in covered tanks, and fill these tanks with our liquid, and mix it with their manure; and if that could prevail to a certain extent, it would enable us to dispose of the liquid at times when it was not so convenient to put it upon the land." Ibid. p. 12. Will be used for moistening dung-heaps.

"There is another way in which it will be disposed of, and that is for watering the dungheaps of all the farmers. There is an immense waste of the very best manure constantly in the country, by the neglect of watering the manure heaps, and this will give great facility for that; and I am quite sure they will be able to add very considerably to the value of the ordinary manure by drenching it from time to time with the liquid manure." Ibid. p. 6.

"I may mention, as connected with our pumping the sewage, that I have no doubt that when pipes are laid down upon farms for the distribution of the liquid manure, that great benefit will be derived in dry seasons from watering the land with common water. I do not doubt that when the system has once been fairly carried out, and people have confidence in it, that we shall see an establishment in every district, not only for the carrying of the sewage manure of the district, but for the purpose of supplying water to the fields." Ibid. p. 18. For irrigation in seasons of drought.

"It would be a very great advantage in a dry season; I am quite sure, in perhaps one summer out of three, that the power of giving water, whether common water, but more especially water mixed with a proportion of Sewage Water in it, would be a very great advantage to land, to give it in a dry period, such as we have seen recently. St. James's Park has been quite brown, and over a considerable district of country many of the crops have suffered very much from the continuance of the dry weather. If there had been power to administer some of this liquid to that land, it would have prevented the decay that has taken place." Ibid. p. 86.

"I have paid attention to the subject of warping, just putting it on; the water is brought in from the sea, and it is formed into a reservoir, which makes a deposit, and the water is let off after the tide has gone out, and thus accumulates a quantity of soil upon it; your sewerage water Warping.

might be applied in the same way ; if you could command a quantity of land within the precincts of London in which you could form it into a level plane, so as to warp it in the same way, the deposit would settle of itself, and leave behind it a valuable residuum for the land, the most valuable in the kingdom."—*Evidence of Mr. D. Magnay, Farmer and Land Agent*, p. 145.

How the expenditure on Sewer Water will be repaid to the farmer.

"Now, in the event of the Sewage Water being sent to the country, it would be some time before people found out what was best for their interest. I suppose they would find this ; that it would be an advantage for every farmer to have a greater proportion of his land in meadow, and to irrigate it to the extent we propose, and as much proportional extent as I have stated here. In the first place, they would find great advantage to their home farm, from having a proportion of the land irrigated, and growing a large quantity of food. It would enable them to keep more cattle ; those cattle would make an ample return for the food raised for them ; they would have the further advantage of raising a greater stock of solid manure : and although I do not doubt that they might supply themselves completely with our liquid manure, without having recourse to solid manure at all, at the same time I think they will have a better cultivation, and more abundant crops, by using a proportion of solid manure—that manure which they will make upon their farms. If we compare the condition of the country round London at present, the general condition of it, with the condition of small portions where there is irrigation and proper management in the application of the manure, we shall find the latter produce one, two, three, and in some cases four-fold. Now one benefit that would arise from the whole of the farmers of the district round London having it in their power to apply the manure would be this, they would bring the whole extent of the land within that range to the highest state of cultivation. We see amazing crops raised in the market gardens, and it is not merely by raising a large crop of its kind, but two and three crops in a year. When land is in a very rich condition you can manage to raise two crops, and in some instances three crops, in a year ; and it is by that means the farmers will be enabled to repay the expenditure they may make upon our sewage."—*Evidence of James Smith, Esq. of Deanston.* Ibid. p. 33.

10. *There are also some incidental advantages attending the use of liquid manure; such as a more rapid growth of the plants watered by it, and the destruction of some kinds of insects.*

"A great, but not sufficiently estimated advantage, which arises from manuring with urine, consists, undoubtedly, in the quicker return effected on the capital of manure, in consequence of its being applied to plants already in a growing state. In the case of manuring with solid excrements, a period of two or three years may elapse before complete decomposition ensues, and the plants have derived the full advantage. The crops, too, during this period, lose much of the manure, in consequence of its best portions being drained away by the snow and rain-water." A quicker return on capital by the use of liquid manure.

"Lastly, one of the uses of manuring with urine, which has hitherto been little regarded, consists in this,—that earth-worms, and the larvæ or grubs of various insects, which in many countries, for instance, on the Upper Weser, do such extraordinary injury to the young rye, are destroyed by it; this effect is produced, as my own experiments made expressly on this point have shown, by the ammonia of the urine; for, if we water a field much infested with earth-worms, with a solution of carbonate or caustic ammonia, the worms come immediately to the surface, writhe for some time, and then die. Probably, also, the cock-chafer grub, when not too deep in the ground, might be destroyed in the same manner; a fact that would be of great importance to many districts."—*On Animal Manures, by Professor Sprengel. Journal of Royal Agricultural Society.* Destruction of insects.

11. *It is admitted on all hands that the value of the Sewer Water is such as amply to repay the expense of its conveyance.*

"If the contents of all the sewers could be brought to a convenient situation for disposal, it would sell for a very considerable sum, and amply repay the cost of any means that might be used to bring it there."—*Mr. E. Cresy. First Report of Health of Towns' Commission,* p. 152.

12. *It is also proved that the conveyance by pipes is much more economical than any other means of transport; and on comparing the relative expense of conveying solid and liquid manure, we arrive at the important conclusion, that the cost of conveying liquid manure by pipes is perfectly insignificant as compared with the cost of the transport of solid manure by carts, while the cost of distributing the liquid manure over the land is but a fraction of the expense attending the application of the solid manure.*

Economy of the conveyance by pipes.

"We can deliver a ton of water at eleven miles distance, and at the altitude we propose to deliver it at, covering all our expenses, and leaving a handsome profit, for *2d.* per ton."—*Evidence of James Smith, Esq., of Deanston.*

The cost of transmitting water to a distance of five miles, and to a height of 200 feet, including wear and tear of pumping machinery, fuel, labour, interest of capital invested in pipes, reservoirs, engines, &c., amounts to about $2\frac{1}{2}d.$ per ton. The cost of cartage to the same distance and height will, under favourable circumstances, amount to *4s.* per ton."—*Evidence of T. Hawksley, Esq. First Report of the Health of Towns' Commission*, p. *322.*

"It is quite clear that a very great weight of liquid material may be moved by pumping more cheaply than by any other known mode of conveyance." Ibid. p. *322.*

The cost of conveying the refuse of towns may be greatly reduced.

"On a full examination of the evidence adduced, and of the evidence indicated, it will, I trust, be found to be satisfactorily established, that the houses of towns may be constantly and rapidly cleansed of noxious refuse by adaptations of drains and public sewers, and that by such adaptation, for one street or one district cleansed at the present expense, three may be cleansed by the proposed mode ; that the natural streams flowing near towns may be preserved from the pollution caused by the influx of the contents of the public rivers, by the conveyance of all refuse through covered pipes ; and that the existing cost of conveyance, by which its use for production is restricted, may be reduced to less than one-fortieth or fiftieth of the present expense of removal by hand labour and cartage."—*General Report of the Sanitary Condition of the Labouring Population of Great Britain*, p. 63.

Water conveyance a fortieth of the expense of cartage

"By the application of capital and machinery, the cost of conveyance of substances in suspension in a fluid, even at the Water Companies' prices, may be rendered thirty and even more than forty times as cheap as collection by hand

labour and removal by cartage. In the metropolis, where the persons who water the roads may obtain water gratuitously from pumps, the water supplied by stand-pipes by some of the Water Companies at 1*l.* per 100 tons is found to be twice as cheap as the mere labour of pumping the water into the cart."—Ibid. p. 53.

In reference to the economical management of liquid manure, Mr. Dean says:—

"The expense of distributing the same quantities of manure, irrespective of the different degrees of productiveness from the different modes of application, would be on the average, for distribution in the solid form, about 3*l.*, and in the liquid form by irrigation, about 6*s.*"

13. *The practicability of the plan of conveying and distributing liquid manure is amply proved by experiment.*

Distribution by the jet.

Experiment by Mr. Smith of Deanston.

"The water could not well be distributed over the open tillage land by irrigation; it would therefore be necessary to resort to some mode of distributing it by jet. This requires the conveyance of the water in pipes, under a pressure of from 100 to 150 feet of altitude, to a number of convenient points in the different farms where it is to be used. In this there is no difficulty: it is a simple engineering question, the success of which is certain, while the cost can be estimated on known data. I made an experiment, on a large scale, at the Southwark Water Works, which satisfied me of the practicability of distribution by the jet. With an altitudinal pressure of 120 feet of water, and using a $2\frac{1}{2}$ inch hose with a discharging orifice or nozzle of one inch in diameter, I found that I could, from one point, distribute water over an area of two statute acres—but, to be safe, say one statute acre. Dividing the quantity so required annually into three portions, for separate applications, one jet of one-inch orifice will deliver each portion in about an hour, as ascertained from data founded on an experiment made the same day to ascertain the quantity of water discharged in a given time from a similar orifice with a similar pressure."—*Evidence of James Smith, Esq. of Deanston. Report of Health of Towns' Commission.* Part ii., Appendix p. 327.

The following account by Mr. W. G. Jolly, Land Agent, in Scotland, of the application of liquid manure, upon a farm in the neighbourhood of Glasgow, belonging to Mr. Harvey, is highly important; it has been in operation for two years.

The liquid employed is the waste from the byres and stables, and from a distillery, collected and pumped up by the same process as I understand this company mean to use, over a stand-pipe, and carried out nearly two miles in a direct line through the fields, three to four miles of pipes altogether.

Mr. Harvey keeps from 400 to 500 cows, and has a distillery on the premises; it is all collected in a well; the steam-engine there is for the purposes of the distillery, which pumps this up over the stand-pipe.

It also contains human manure to a very small extent.

It is taken out in cast-iron pipes, three inches in diameter, through the fields; and there are cocks at different parts, and a hose is applied, which goes from any part, and is then distributed by tin pipes added on, so many of them about six feet six in length, and the others about three feet in length. There is no labour, but a single man or boy to watch it and distribute it over; they may do it by jet. He does not use a jet.

Some of the land is in ridges, and some of his fields are flat; and it has a much better effect when the land is flat; on a ridge it is apt to run into the furrows.

It is found to distribute it very equally over the land; and though it is run on at every three feet or three feet and a half, you would not know the difference of the crop, unless they miss a bit, and then it is marked.

I should say that the distribution of manure in that way is by no means so offensive as by applications of common farm-yard manure.

I saw the tanks full and empty, and particularly wished to examine whether there was any deposit; they have never required to be cleaned out, except at first. They put up an agitator to take it all, supposing the article to be deposited the best of it; they found out by experience that it was by no means the richest part, and they have ceased to use the agitator, by which means the first tank it flows into requires occasionally cleaning out.

Applied with good results to all sorts of crops.

He farms various qualities of land; and he has applied it to all sorts of crops, and with universally good results.

On pasture-land it has had the most beautiful effect; the

cattle seem to like the parts done with it; they eat it much more greedily; if a part is missed, the cattle will leave that. The grass grateful to cattle.

I should say that land that formerly he could not cut more than once, he will cut this year three times. It is common rye-grass.

This year he has applied it to oats, after they were brairded; most of the people thought it would have destroyed them. I went back afterwards, in five or six weeks, and the effects were wonderful; I should say double the amount of the crop upon the part done with it, compared to the part that was not, and so distinctly marked, that at half a mile distance you could see the parts missed; the field is cold clay land.

I estimate the crop at double what it would have been without it. I could not say how many quarters, with any accuracy, at that stage of the crop.

From the dressing he is in the habit of giving per acre, he has a much greater result than from any quantity of farm-yard manure I have seen applied.

He has 300 acres, which is now nearly all in fine condition from that; and I should think, from the supply, that he has equal to twice 300 acres; he has more than he requires—so much so, that after this year, he will not require any solid manure; he is selling it.

He put up this apparatus two years ago, and he is so thoroughly convinced of the advantage of it, that he recommends it very strongly.

The following evidence laid before the Select Committee on Metropolitan Sewage, by Mr. Chadwick, is highly important in reference to the applicability of the plan of distribution by pipes.

"In the summer of 1842, I was staying with a friend, Mr. Thomson, of Clitheroe, where Dr. Lyon Playfair was also staying. Mr. Thomson has extensive print-works, where he employs about 1,000 persons, and from the works has much liquid manure."

"Mr. Henry Thomson pumped up the Sewage Water from a well or shaft, into a tank made at the top of a field about eighty feet above the rest of the farm. He found that, under that eighty feet pressure, by means of the hose, with the labour of two men, one to remove the hose, and another to direct the nozzle, they could distribute about 2,000 gallons of liquid manure in an hour."

"The important result was this, that it was to be accomplished by the labour of two men, and suppose we

Economy of the application by the hose: 6*d.* by the hose, 5*s.* by the water cart, and 11*s.* or 12*s.* for the distribution of stable manure.

give $2\frac{1}{2}d.$ or $3d.$ an hour, that delivery of the 2,000 gallons was accomplished for $6d.$" The expense of delivery of the same quantity by water-cart was, I think, about $5s.$; the expense of loading and spreading stable dung was about $11s.$ That was about the relative mechanical cost:—$6d.$ for the delivery by the hose, $5s.$ by the water-cart, $11s.$ or $12s.$ in the distribution of stable manure—an equivalent quantity, and that close to the farm. Then there was this great advantage in favour of the hose, though you cannot give an estimate in money value as to the relative amounts, that in the distribution by the water-carts there is the poaching of the land by the weight of the cart and horse, and probably the damage of which would be more than 5s., and of course still greater damage in the case of the cartage of the heavier produce of stable manure.

Advantage of

With the hose the experiment appeared to be complete, with the addition of a very important fact, that you could by the hose get on the land at any time, but with the water-cart, or in spreading solid manure, of course you are restricted by the state of the weather as to its application to certain periods. So far as they could try, I think these 2,000 gallons of Sewer Water were found equal to about 3 cwt. of guano, and about 15 tons of stable manure. But there was another important point which was established beyond a doubt, which was, that the friction through the hose, for a considerable length, was much less than we anticipated; for instance, we used half a mile of hose, and carrying it on the surface, over furrows and through a ditch and over a hedge, I think at the end of 800 yards it gave out a jet, something, as near as I could judge, of 40 feet—nearly half the height due to the pressure. These experiments appeared to establish the fact, that the hose, in many circumstances, for the delivery of a given quantity of water, even considering it as a means for the distribution of simple water, would have been cheaper than the water-meadow itself; and you have the advantage, also, with that, of being able to apply the liquid manure to arable cultivation. With the water-meadow you only apply it to grass land. "Putting the interest on the machinery and capital together, we could not put down the fair expense of this delivery by the hose at much more than $1s.$ an acre, that is for 2,000 gallons."

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